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**Published**
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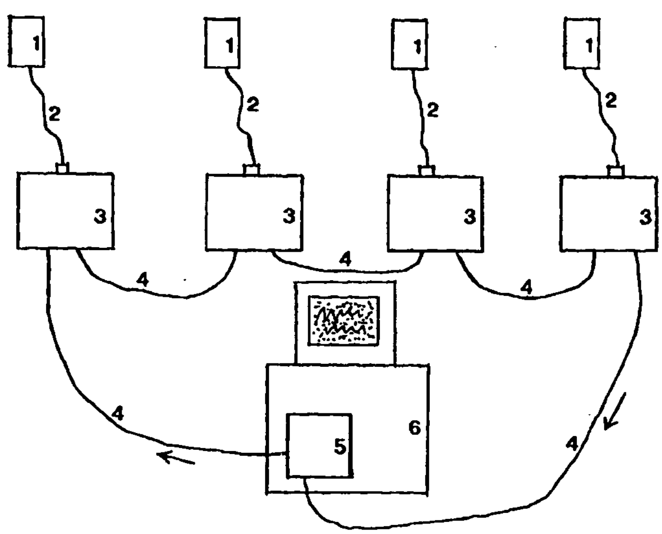
(54) Title: AN OPERATIVE NETWORK FOR DIGITAL DENTAL IMAGING





(57) Abstract

An operative network system for dental examination equipment is disclosed for the use of several imaging devices at a number of separate dental treatment positions, e.g. chairs in a dentist's operatory. The system further contains a common computer device (6) including programs, data storage and means for presentation of acquired data, insulating transfer means, e.g., in the form of opto-fibers or transducers using infrared light, for transferring signals to the common computer (6) from the imaging devices (1) being locally positioned at each separate dental treatment position including isolated power supplies (22) allowed for use within a defined medical environment for each such chair position, and a master control and image interface unit (5) within the operative network cooperating with the common computer (6) and the imaging devices (1), for grabbing image data from each imaging device for storage and presentation by the common computer as well as by the operative network. The common computer (6) is then normally positioned outside the restricted defined medical environment.

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# AN OPERATIVE NETWORK FOR DIGITAL DENTAL IMAGING

## Technical field

The present invention relates a system for connecting several dental imaging systems to one common personal computer for storage of images and control and buffering of the imaging systems used.

## Background of invention

Since mid 1980:s, new methods for electronic registration of intraoral X-ray images have become available.

All these methods employ a solid state X-ray detector to be placed in the mouth of a patient and a means to read the energy integrated and stored in the detector as a result of an X-ray exposure. This means creates a sequential electrical signal, the signal level of which corresponds to the amount of radiation absorbed in each individual pixel of the detector. Two basically different detector systems have been used. On one hand electronic detectors of the CCD type, wherein the division into pixels is achieved directly in the silicon chip by certain structures and application of bias voltages via electrodes, and on the other hand storage phosphor image plates, which have the potential to store a certain amount of the absorbed X-ray energy until a later scanning procedure. With storage phosphors, the division into pixels is achieved during the scanning procedure.

Both methods employ a subsequent step in which the analog signals are converted into digital, binary data, which is transferred into the memory of a computer for storage, administration, image processing and presentation on a video monitor. In most of the current systems, the computer with the software also serves the purpose of controlling the electronics that is necessary to scan a CCD detector or a phosphor plate.

One of these methods involves a CCD detector as the final photon detector. In the first system introduced, the X-ray photons were absorbed by a fluorescent screen acting as an energy converter to

visible light of a wavelength suitable to a conventional CCD detector. Since the conventional CCD detector was to small to depict a whole tooth, a tapered bundle of optical fibers was placed between the larger fluorescent screen and the smaller CCD to scale down the image of a tooth to a format suitable for a standard CCD.

U.S. Patent Application No. 4,160,997, disclosed the possibility to use both an energy converter and a fiber optics layer.

European Patent Application No. 0 129 451 disclosed the use of a tapered bundle of fiber optics to scale down the image.

In the beginning of 1990:s another system was introduced that employed a CCD, sufficiently large to depict a whole tooth and the surrounding tissues, without any fiber optics to scale down the image. Another difference was that the detector was adapted for direct detection of X-rays in the silicon. This meant that the fluorescent layer could be omitted.

In the first system, the synchronization with the X-ray source was solved by a hard wire connection to the timer of the dental X-ray source. In the later systems, the synchronization has been solved by using separate trigger detectors close to the CCD detector or by continuously monitoring the signal level received from the output of the CCD detector as disclosed in the European Patent Application No. 0 415 075, the International Applications PCT/SE92/00369 and WO93/25059. At certain threshold levels for the incident X-ray flux, the status of the detectors are switched from standby mode to integration mode. Subsequent to the integration, the image data is read out from the detector. This readout can be triggered by the detection of the end of the X-ray pulse or by a timer in the control electronics or computer software.

In the electronic detector based systems, it has been necessary to introduce a means to galvanically separate the detector end

from the computer since the personal computers generally used for the computer functions described above are not approved for use in a medical environment, while on the other hand the detector has to fulfil the regulations for medical electronics. This can be solved by the introduction of, for instance, opto-couplers in the signal path and a separate medically approved power supply for the detector as is taught in the International Application PCT/SE92/00812.

For storage phosphor plates electrical safety does not require special solutions since during the exposure, there is no electrical connection between the detector plate and the scanning system.

The two different kinds of systems, electronic detector based and storage phosphor based, has both advantages and drawbacks, respectively. Among the advantages with the electronic detector based systems, one of the most important, is the close to instant readout and presentation of the X-ray image on a monitor after the exposure. This gives the dentist instant feedback, for instance, during the preparation and filling of root canals. A delay might spoil the possibilities to adjust the depth of the gutta-percha point used to seal the canal before the adhesive used cures. This might in some cases make it necessary to redo the whole root canal procedure. There are many other examples where the immediate feedback is of a great value.

With the storage phosphor plate based systems, the scanning procedure usually takes approximately 30 seconds which in many cases, like root canal treatment, is to slow to give the dentist the feedback when needed the most.

An advantage with storage phosphor based systems, beside the freedom of electrical connections to the plate during the exposure, is the possibility for several dentists to share a common scanner. The phosphor plates themselves are relatively cheap so each of the dentists sharing one scanner can have

several plates in stock.

For electronic detector based systems, the investment per dentist is usually much higher even if the group of dentists can share some resources like a server in a network. With the present products each system requires its own computer and software for control of the operation. This means in practice that there is a requirement of a computer installation for each chair in the operatory to make the technology really accessible. To some extent, the installation investment cost can be reduced if a computer and drive electronics/isolation unit is installed at each chair and the sensor unit itself is shared between the chairs by simply unplugging it and moving it to the next dentist or chair where it is needed. Common to the electronics detector based systems is that the detector itself is the most expensive part.

The connection of several detector drive electronics units to one common computer over some kind of switch box or demultiplexer has also been described. Unfortunately this leads to difficulties with all the cable installations. The cables and connectors required for high speed transfer of large amounts of image data are usually very thick and clumsy and does not fit in very well in a dental operatory. Cables and connectors are also prone to create reliability problems.

Another solution suggested, has been to use a small, portable computer with the capacity to store and display a few images, to operate the detector. This way, the detector and computer can easily be moved between the dentists /chairs when required. This leads to reliability problems as always with battery operated equipment.

It also requires that the information temporarily stored in the computer is regularly moved to a more permanent computer based storage and presentation system.

Short description of the invention

An object of the present invention is to provide a system where several detector drive electronics units can be connected to one computer for control of exposures, storage and display of images. In this way a detector can be shared between several dentists or chairs by simply plugging in the device to the appropriate drive electronics unit when needed.

A second object of the invention is to provide a separation of the detector/drive electronics unit designed to be approved for use in a medical environment from a computer not being approved for use in a medical environment. This separation is achieved by performing the communication between the sensor drive electronics and the computer through an insulating transfer device, e.g. optical fibers in a ring network, infrared light in a star network or a "fork" network using a multiplexer or a more simple junction box with several optical repeaters such that signals from one single input line is repeated onto a number of output lines, or vice-versa, signals from several input lines being joined into one output line. The latter direction requires a means for arbitration between incoming signals.

Low cost optical fibers or infrared communication also to a great extent simplifies the installation where a great flexibility is achieved for customizing, for instance, the length of the cables. Reliability problems related to metal conductor cables and connectors are also avoided.

Another object of the invention is, in order to keep the cost down, to let the detector drive electronics units be slaves in the network just responding to a few commands from the computer or being able to send a limited set of commands to the computer to activate certain software functions for sending imaging data to the computer.

Short description of the drawings

The invention, together with further objects and advantages

thereof, may best be understood by making reference to the following description taken together with the accompanying drawings, in which:

Fig. 1 Drawing of a typical state of the art CCD-based intra-oral X-ray imaging system;

Fig. 2 Block diagram of the configuration of a preferred embodiment;

Fig 3 Block diagram of a detector control node (slave node); and

Fig 4 Block diagram of a master control and image interfacing unit/optical I/O card for the computer (master node).

Description of an illustrative embodiment

In Fig. 2 is demonstrated the configuration of an illustrative embodiment including one or several electronic image generating devices, for instance, in the illustration, an X-ray detector 1, to be at hand at a chair-side and in this case ready to be inserted into the mouth of a patient to record an X-ray image whenever required. Each X-ray detector 1 is connected through a cable 2 and a connector to a combined detector control and communication unit 3 being provided with its own power supply, which supplies power to the unit and the detector. The power supply 22 (Fig. 3) is designed according to electrical safety regulations for a medical environment. The energy for the power supply could be provided by means of a unit fed from the mains or even a suitable battery. Each detector control and communication unit 3 is connected to all the other control and communication units in a ring of optical fibers 4. The ring also includes a master control and image interfacing unit 5, for simplicity hereafter referred to as an image grabber, which in a preferred embodiment is incorporated within a computer 6 provided with the necessary software and I/O units like keyboard, screen, printer/plotter etc. Each of the detector control and communication

units has one optical transmitter unit and one optical receiver unit and the same is valid for the image grabber unit presently within the computer. Consequently, each of the detector control and communication units 3 and the image grabber unit 5 in the computer are connected to two optical fibers 4, one for input and one for output, otherwise the ring will be broken. The arrows adjacent to the fibers 4, indicate the direction of the data flow.

In Fig. 3 a block diagram demonstrates the design of a detector control and communication unit 3. The control and communication unit 3 is supplied by its own power supply 22. In the preferred embodiment this unit works as a slave node in the optical network. A command or image data is received in the optical fiber serial receiver block 7. Data is converted into parallel words, in the preferred embodiment with a width of 10 bits, in a serial-to-parallel converter block 8, typically a shift register. The data words are continuously monitored by an address detector block 9 that determines if the received word is a valid address and compares it with the settings of an address selector dip-switch device 10. If a match is detected, the address detector generates a control signal that enables the mode control logic block 11 to change the operating mode from, for example, standby to a mode "ready for exposure". In the preferred embodiment this would mean that the clock signals to the a CCD in an X-ray image detector 1 are changed from a static situation with fixed levels to a sequence of clock signals from a CCD clock generator 24 required to clear the detector from dark signal. It will also activate the logic necessary to synchronize the detector with the X-ray source. The control signal from the block 9 would also re-direct the data path in a parallel data multiplexer block 12 such that image data can be transferred to the serial transmitter block 13 through a parallel-to-serial converter block 14 when the x-ray exposure is finished.

In the case of a mismatch between the data word received and the conditions determined by the address detector block 9, the data

word will just passively be transferred via the multiplexer block 12 to the serial transmitter block 13 and over the optical fiber to the next node in the ring.

In Fig. 4 the configuration of the image grabber unit is described. The computer 6 writes via its software a command or data via its computer bus interface 21 to an output register block 15. The data is converted into serial data by a block 16 and is then transmitted to the fiber by a serial transmitter block 17.

In the illustrative embodiment the computer and the image grabber unit constitutes the master node - only commands are issued along the path from this block, i.e. the image grabber serves as a master control and image interface. However in other configurations where another node could take over the role as the master node, the output portion of the image grabber unit can be used for transfer of data received in the input portion. In such a case the image grabber unit would work as a passive slave with the only duty to serve as a repeater.

In the input circuitry of the image grabber unit, a decoder and multiplexer block 18 interprets the incoming data words, via a serial receiver block 7′ and a serial to parallel conversion block 8′, to check whether or not those represent commands, status information or image data. Blocks 7′ and 8′ are similar to blocks 7 and 8 of Fig. 3. Command words or status words are transferred to an input register block 20 and image data is transferred to a frame buffer memory block 19. In this case the frame buffer block consists of a 1 Megaword memory having a word length of 12 bits. Since the image data in the preferred embodiment has a word length of 10 bits, two bits are left for other use, such as error correction information or the like. The frame buffer memory block 19 and the input register block 20 are communicating with a computer bus interface 21, which also in turn communicates out to the output register block 15.

The illustrative embodiment uses a combined optical transmitter and fiber connector of the type HFBR-1526 from Hewlett-Packard. The serial output data is first fed to a connection point and transferred over driver stages to transmitter blocks.

At the input a combined optical receiver and fiber connector of the type HFBR-2526 is used and connected to receiver blocks. The remaining electronic circuitry, mainly amplifying and wave forming stages to shape the serial bi-phase encoded data is utilizing techniques well known to a person skilled in the art and is therefore omitted in this description.

Once setup, the system operates in such a way that the computer software, on the operator's demand to activate a detector control unit, issues an optically encoded activation command in the transmitter logic of the image grabber unit. The command contains an address word for a certain slave control and communication unit. When received by the first of the slave control and communication units, the address is checked by the receiving unit against an address selected by a switch at installation of the system.

The command is immediately transferred via the detector control and communication transmitter of the unit to a next control and communication unit in the ring. After passing through one or several control and communication units, the optically encoded command is fed back to the optical input of the image grabber unit. When received in the image grabber unit the computer software can check the integrity of the command or data transferred through the ring.

Since each of the detector control and communication units 3 is given a unique address when installed, an activation command with the correct address for a given control and communication unit 3 will set it in a mode ready to record, for example, an X-ray image.

When an X-ray detector 1 connected to the activated control unit has received an X-ray image exposure, the control and communication unit 3 immediately begins a readout in a sequence, pixel for pixel, from the detector via an analog amplifier 23. In the control and communication unit, an analog to digital converter 25 converts the recorded analog pixel signal to a digital value, transferred to a transmitter register 26. The digital signal is subsequently by a parallel to serial converter 14 converted into an optically encoded serial bit-stream in the transmitter unit and via a serial transmitter 13 feedin the optical output fiber to the next detector control and communication unit which automatically, without significant delay, repeats the data to a next node in the ring. The last node in the ring is always the image grabber unit, in the preferred embodiment, inserted into a bus slot of the computer. When the data stream is received in the image grabber unit, the data is stored in the memory of the image grabber unit to be subsequently processed by the computer. The processing might comprise operations such as displaying on a monitor or storage in a file.

As the minimum, the network must contain two nodes, one image grabber unit/computer 5, 6 that serves as master node and one or more image detector control and communication units 3 that serves as passive or active slave units. In the preferred embodiment only one slave node is activated at a time but with an additional communication arbitration between nodes it will be possible to implement a system where a slave node asynchronously could be locally activated and used for the recording of an image. This implies that the operator would not have to initialize the computer to activate a certain unit. In this case, the sequence of events in the network could be as follows:

An event in the slave image generating node such as the end of an X-ray exposure or a button pushed causes the actual slave unit to send a data package over the ring containing a command to the master node. The command also contains the identification address of the imaging node to be activated. The software in the master

node interprets the command and issues an ordinary activation command with the proper address after having processed any unfinished image transfers from other nodes. The protocol for this can be elaborated such that the imaging nodes can be used nearly asynchronously without any significant ring overload problems. Sometimes, in the preferred embodiment not having any storage memory locally at the imaging node, the delay before the activation is acknowledged could be a second or so because some other imaging node has to finish up first.

In another embodiment, the imaging nodes may include a storage memory for temporary storage or buffering of the image data before it is transferred over an operative network like an optical communication ring. In this case, the data could be transferred during a suitable time slot after the exposure is finished. This would lead to the possibility to have all the image generating nodes activated simultaneously, letting the master node transfer data from each of those during convenient time slots.

Other image generating nodes that might be needed in dentistry, such as panoramic X-ray units and intra-oral or extra-oral video cameras or an image scanner could then be hooked up to the operative network as well.

Also, special image receiving slave nodes like display, printer or storage nodes could be included in the operative network. A display node could be used both for checkup of a recently acquired image before it is sent to the master node for storage or for display of previously stored images needed during the dental treatment procedures. The minimum configuration for a display node would be an optical receiver/transmitter connected to a display memory and a monitor. A slave node like a display, a printer or a scanner etc., will also contain an own buffer memory when necessary. If supposed to be placed chair-side, it would be an advantage to use a flat monitor like the TFT screens used for portable, lap-top computers. Similar configurations can

be designed for printer nodes. Storage nodes would comprise the optical receiver/transmitter and a suitable mass storage memory such as an optical or magnetic storage disk drive.

It should also be noted, that the use of low-cost optical fibers for communication to a great extent makes it easier to integrate both imaging nodes and display nodes into the dental unit. The space required and the size of the through-holes is very much reduced compared to conventional cables and connectors. The optical fibers also makes it easy to ensure that all the electrical safety regulations are fulfilled for an integrated installation in a dental unit. In another embodiment instead of the optical fiber a star shaped network may be introduced utilizing infrared communication or a very high radio linking frequency, which will further simplify cabling and isolation between the common computer master and active or passive slaves.

Another advantage with the optical communication between the nodes is that it is easier to design the nodes so that regulations for EMC (ElectroMagnetic Compliance) can be fulfilled. For an X-ray acquisition node in the preferred embodiment the major parts emitting radio frequency radiation during operation would be the cable from, for instance, the X-ray image detector, the electronics in the imaging unit and the power supply line. In a standard, state of the art system, an additional cable for high speed data transfer between the imaging unit and the control/ storage computer would be required and such a cable unfortunately tends to work as an antenna.

In a preferred embodiment, two optical fibers are used for the interconnection of each node, one for received data and another for transmitted data. In another embodiment a single fiber could be used for both directions. One example of this would be a system where each node includes a combined receiver/transmitter unit where two separate light wavelengths are used for received and transmitted data respectively. This kind of implementation would, however require more expensive fibers and transmit-

ters/receivers than low cost plastic fibers suggested for the preferred embodiment. Another example for sharing one fiber for both directions would be a time sharing protocol, where transfers in each direction occupies certain time slots. However, it must be kept in mind that this kind of protocol would require receiver/transmitter circuits and fibers with higher speed to achieve the same performance as for the two-fiber solution.

In the preferred embodiment, the transmitter/receiver fiber link has a speed limitation of 25 Mbit/sec. A bi-phase encoding protocol is used, even if other protocols might be equally useful. During a data transfer cycle some of the bandwidth is used for protocol dependent data transfer, such as a transfer of control characters. This reduces the achieved transfer rate to approximately 15 Mbit/sec. In the preferred embodiment, the analog pixel data from the detector is converted to 10 bit data before transmitting. Thus, a transfer speed corresponding to approximately 1.5 million pixels per second of image data is achieved. A standard X-ray detector having 600 x 400 pixels would then require 0.16 seconds for a complete image frame transfer. This speed is sufficient in relation to the limitations for a CCD. The minimum readout time is usually limited by the highest allowed readout rate of approximately 1 million pixels per second for a 20 x 30 mm detector and the maximum readout time of a few seconds is usually limited by the build-up of dark current charge that reduces the useful dynamic range if allowed to grow to high. This simple calculation also shows that no large, intermediate buffer memory is required in the imaging node as long as the receiving node (image grabber unit) has the capacity to store the frame with the required speed. In the preferred embodiment this receiving node is a card for an ISA bus slot in the computer. Since the ISA bus has a limitation in bandwidth it has been chosen to include buffer memory for one complete frame on this board. However, since other computer bus implementations such as the PCI allows higher speed transfer, a system without any intermediate storage memory could very well be designed. In such a case, the data received in the computer node would be stored

directly into the RAM memory or hard disk of the computer.

In the preferred embodiment, only the computer together with the image grabber unit module can act as a master node in the operative network. It is however possible to further develop the invention such that any of the connected nodes containing processor capability can take over the role as a master node. In this case all the other units would become slaves and the status of the previous master node would change into a slave node on the operators demand or on a request generated by the system itself depending on certain pre-set conditions.

It will be understood by those skilled in the art that various modifications and changes may be made to the present invention without departure from the spirit and scope thereof being defined by the appended claims.

## CLAIMS

1. An operative network system for dental examination equipment including a number of separate dental treatment positions, e.g. chairs in a dentist's operatory, comprising:

a common computer device (6) including program and data storage and means for presentation of acquired data;

a number of imaging devices (1) including a combined detector control and communication unit (3) producing image signals for dental examinations;

insulating transfer means (4) for transferring signals to said common computer device (6) from said imaging devices, each of said imaging devices (1) being locally positioned at each separate dental treatment position;

an isolated power supply (22) for each such chair position supplying said imaging device 1 and said combined detector control and communication unit (3) with electrical power, said isolated power supply being allowed for use within a defined medical environment;

a master control and image interface unit (5) within the operative network cooperating with said common computer device (6) and said imaging devices, for grabbing images from each of said imaging devices (1) for storage and presentation by said common computer device as well as the operative network, said common computer device (6) preferably being positioned outside a defined medical environment.

2. The system according to claim 1, wherein each one of said imaging devices (1) has its own specific identification within the operative network for utilizing said common computer device (6) as a central controller of the entire dental examination equipment.

3. The system according to claim 1 or 2, further comprising: an analog to digital converter (25) at each analog imaging device

4. The system according to claim 1, wherein said insulating transfer means (5) is an optical transfer device.

5. The system according to claim 1, wherein said insulating transfer means is an electromagnetic transfer device operating wireless and using a communication carrier frequency having a limited controlled propagation range, e.g. infrared light or very high linking radio frequencies.

6. The system according to claim 4 or 5, wherein said insulating transfer means is a two way communication arrangement.

7. The system according to claim 6, wherein said insulating transfer means for the operative network presents a star shaped communication arrangement or a ring shaped communication arrangement.

8. The system according to claim 1, wherein said common computer device (6) acts a master in the operative network and all other units act as slaves with or without own computing capability, said slaves being either active or passive slaves.

9. The system according to claim 8, wherein said active slaves being either said master control and image interface unit (5) or said number of imaging devices, each of which being either an intraoral X-ray imaging detector, a digital panoramic X-ray device, an image scanner, an intra-oral or extra-oral video camera; and

wherein said passive slaves being either a display device, a printer device, an image plotter device or a storage device.

10. The system according to claim 9, wherein each of said active slaves will be able to call upon said common computing device centrally controlling the operative network for obtaining services by said central controller.

PRIOR ART

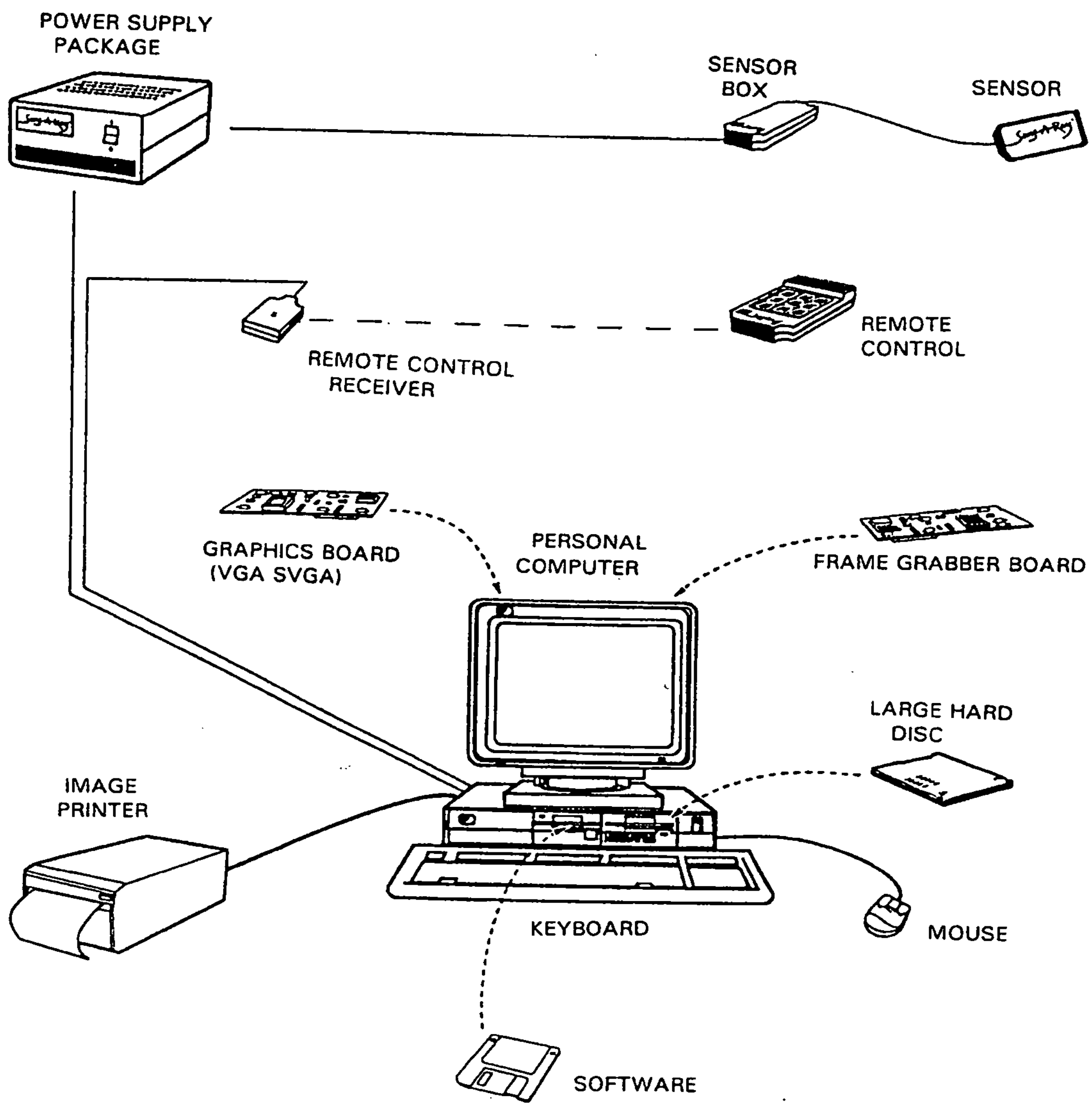



Fig. 1

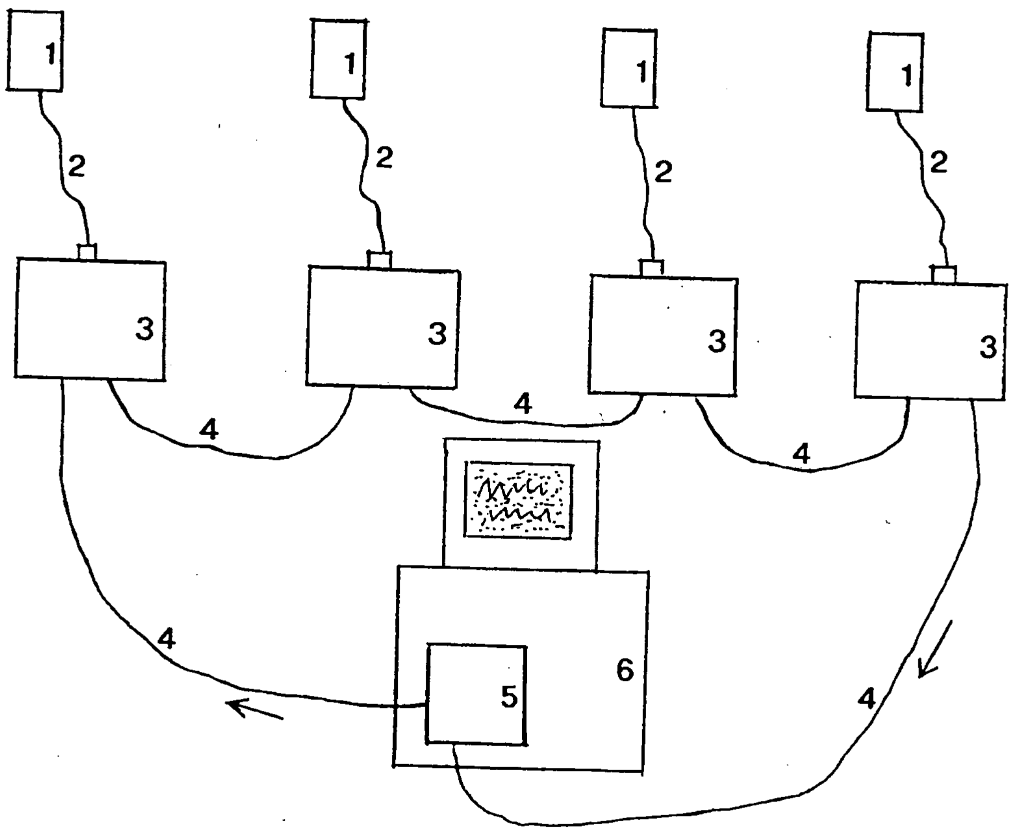
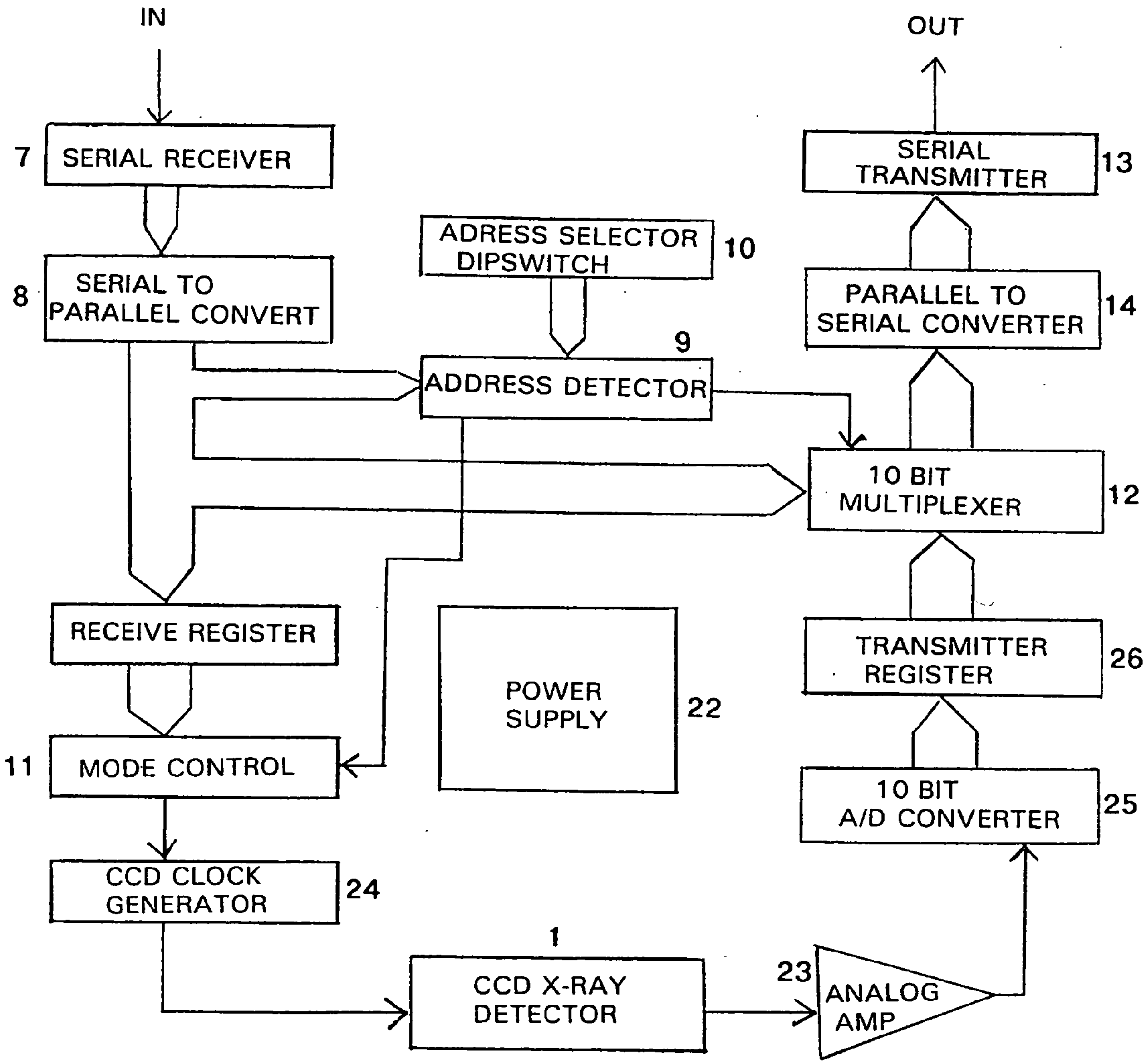



Fig. 2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OUT
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SERIAL RECEIVER
SERIAL TRANSMITTER
13
ADRESS SELECTOR DIPSWITCH
10
8
SERIAL TO PARALLEL CONVERT
PARALLEL TO SERIAL CONVERTER
14
9
ADDRESS DETECTOR
10 BIT MULTIPLEXER
12
RECEIVE REGISTER
TRANSMITTER REGISTER
26
POWER SUPPLY
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MODE CONTROL
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CCD CLOCK GENERATOR
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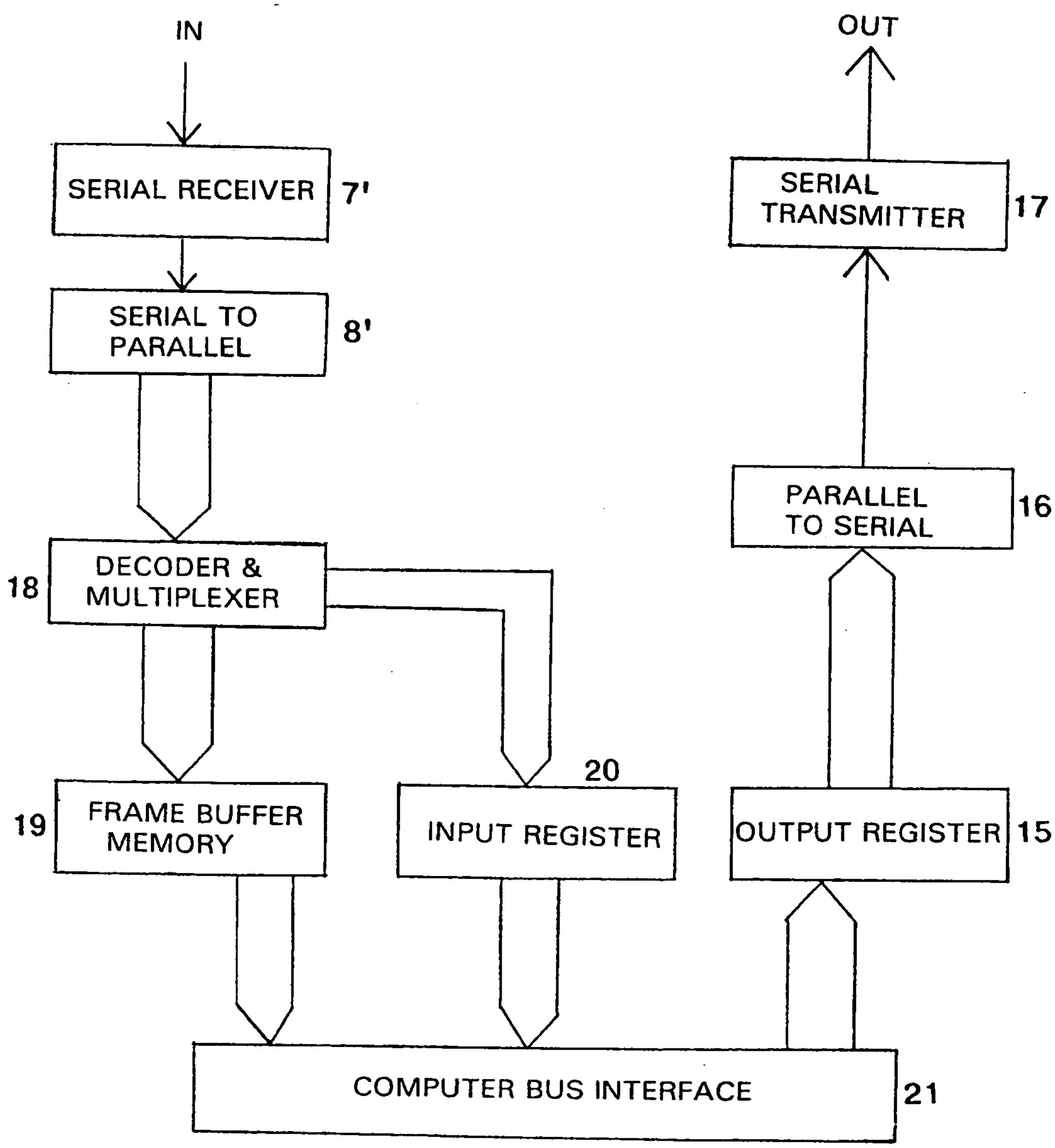
CCD X-RAY DETECTOR
23
ANALOG AMP

Fig. 3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OUT
SERIAL RECEIVER
7'
SERIAL TRANSMITTER
17
SERIAL TO PARALLEL
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PARALLEL TO SERIAL
16
DECODER & MULTIPLEXER
18
20
FRAME BUFFER MEMORY
19
INPUT REGISTER
OUTPUT REGISTER
15
COMPUTER BUS INTERFACE
21

Fig. 4

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 97/01674

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: A61B 6/14
According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: A61B, A61C, G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | US 5434418 A (D. SCHICK), 18 July 1995 (18.07.95), column 4, line 42 - line 59; column 5, line 15 - line 16; column 6, line 32 - line 38 -- | 1-10 |
| Y | WO 9310709 A1 (JOHANSSON, BENNY), 10 June 1993 (10.06.93), abstract -- | 1-10 |

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☐ Further documents are listed in the continuation of Box C.  ☒ See patent family annex.

- * Special categories of cited documents:
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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 12 January 1998 | 29 -01- 1998 |
| Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86 | Authorized officer Malin Keijser Telephone No. +46 8 782 25 00 |

**INTERNATIONAL SEARCH REPORT**
Information on patent family members

02/12/97

International application No.
PCT/SE 97/01674

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| US 5434418 A | 18/07/95 | NONE | |
| WO 9310709 A1 | 10/06/93 | AU 3099992 A | 28/06/93 |
| | | BR 9206840 A | 31/10/95 |
| | | EP 0544974 A | 09/06/93 |
| | | JP 7501724 T | 23/02/95 |
| | | US 5671738 A | 30/09/97 |